XC83x

AP08127

inTouch Application Kit - Touch Buttons

Application Note

V1.0, 2012-02

Microcontrollers

Edition 2012-02

Published by
Infineon Technologies AG
81726 Munich, Germany

LEGAL DISCLAIMER

THE INFORMATION GIVEN IN THIS APPLICATION NOTE IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. INFINEON TECHNOLOGIES HEREBY DISCLAIMS ANY AND ALL WARRANTIES AND LIABILITIES OF ANY KIND (INCLUDING WITHOUT LIMITATION WARRANTIES OF NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

Infineon Technologies components may be used in life-support devices or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

XC83x
Revision History: V1.0 2012-02

Previous Version(s):

Page	Subjects (major changes since last revision)
–	

We Listen to Your Comments
Is there any information in this document that you feel is wrong, unclear or missing? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:
mcdocu.comments@infineon.com

Table of Contents

1 Introduction

In today's Human-Machine Interface (HMI) designs, capacitive touch technology is now often more widely used than traditional mechanical buttons. Capacitive touch technology is the more popular choice because it brings flexibility, a high-level of customization, and a significant reduction in overall system cost.

The *inTouch Application Kit* is available to help learn about working with the advanced touch solutions provided by Infineon. Step-by-step tutorials covers the basics of Infineon's touch solutions, while example application code can be used to start developing new touch-related projects.

The *inTouch Application Kit* comprises of a mother board, supplied as a USB stick, and a number of daughter boards. **Figure 1** shows the buttons daughter board.

Among the many different touch input elements that can be designed with capacitive touch technology, the single pad button is probably the simplest and most popular. This application note describing the buttons daughter board, aims to highlight the ease of implementing a design with Infineon's touch solutions. Topics covered include program flow and touch behavior.

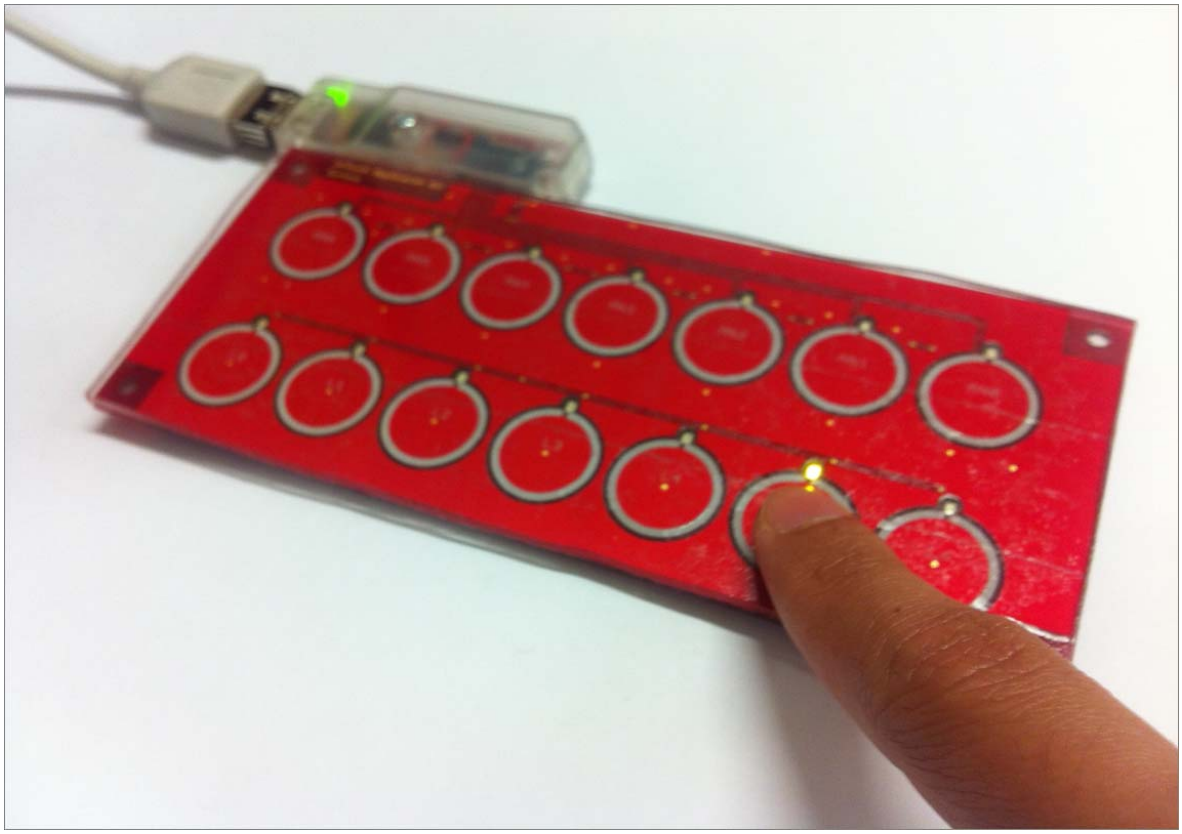

Figure 1 *inTouch Application Kit* (USB Stick and Buttons board)

2 Hardware and Program Flow

This section describes the hardware used and the connections involved.

2.1 Hardware

Infineon's XC836MT 2FRI (**Figure 2**) is used in this application. The XC836MT is embedded in the *inTouch Application Kit*'s USB stick. For more details regarding the USB stick, please refer to *AP08126: Infineon Touch Solutions - inTouch Application Kit*.

Figure 2 Infineon's XC836MT 2FRI

The *inTouch Buttons* board (**Figure 3**) is available as a plug-in daughter board which is part of the *inTouch Application Kit*.

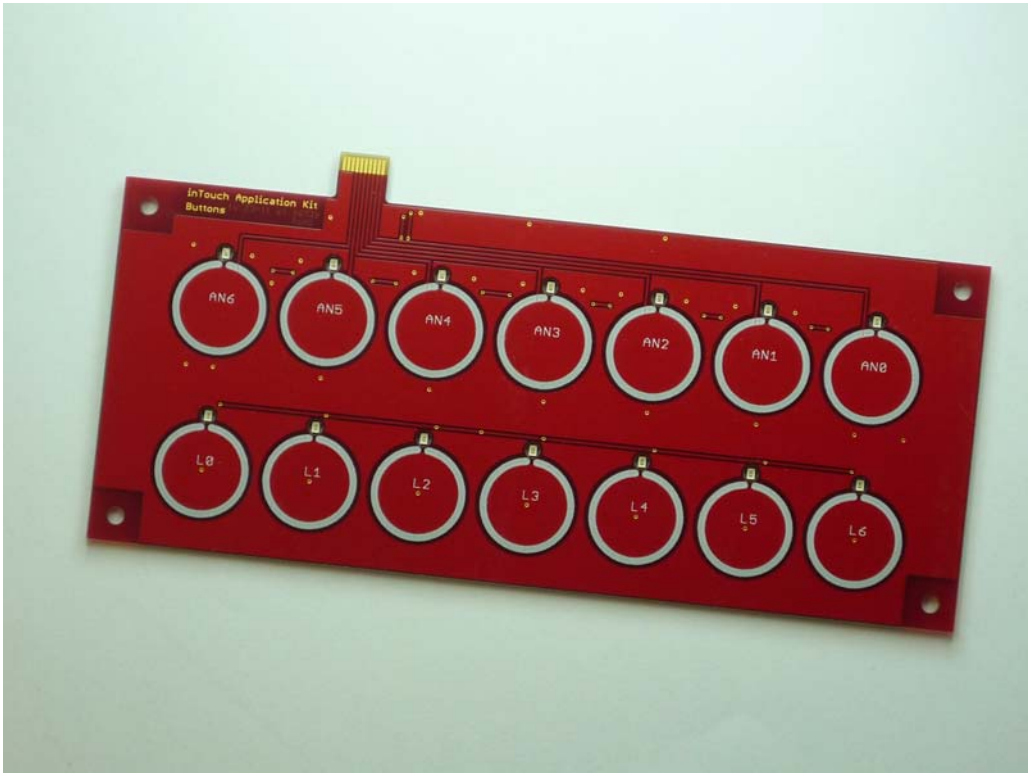

Figure 3 Buttons daughter board

The *inTouch Buttons* board is a standard PCB with a piece of 2mm-thick plexiglas glued on top of the board. The buttons on the top row are each connected to an ADC input channel of the XC836. The buttons in the bottom row are each connected to an LEDTS input pin of the XC836. 14 indicator LEDs are connected to 2 LED column pins (1 for each row) and 7 LED line pins of the XC836. The schematics are available in the **Appendix - Schematics and Layout**.

Users can touch-and-hold (default) or tap the 14 buttons to toggle the indicator LEDs depending on the downloaded software.

2.2 Program Flow

Infineon offers 3 solutions for capacitive touch sensing. The bottom 7 buttons, which are connected to LEDTS input pins and hence controlled by the LEDTS module of the XC836, use the Relaxation Oscillator Topology for touch sensing. The top 7 buttons, which are connected to ADC input pins, can use either the Charge Redistribution (CR) or the Charge-Time Measurement (CTM) methods for touch sensing. Because two options are available, the program name in the program flow description is taken from the name of the method (CR or CTM) used for the top 7 buttons.

For more information on the 3 touch solutions, refer to the application note *AP08126: inTouch Application Kit - USB Stick*.

In terms of interrupts, UART interrupt has a medium priority because of the high data rate. Touch sense related tasks are also performed with medium priority. These occur in the Time Frame interrupt after pad capacitances have been measured. LED updates have the lowest priority. These are performed in the Time Slice interrupt together with pad capacitance measurement. These apply to both CR (**Figure 4**) and CTM (**Figure 5**) methods.

In the CTM method, the ADC interrupt is enabled and this has the highest priority to facilitate accurate charge time measurement.

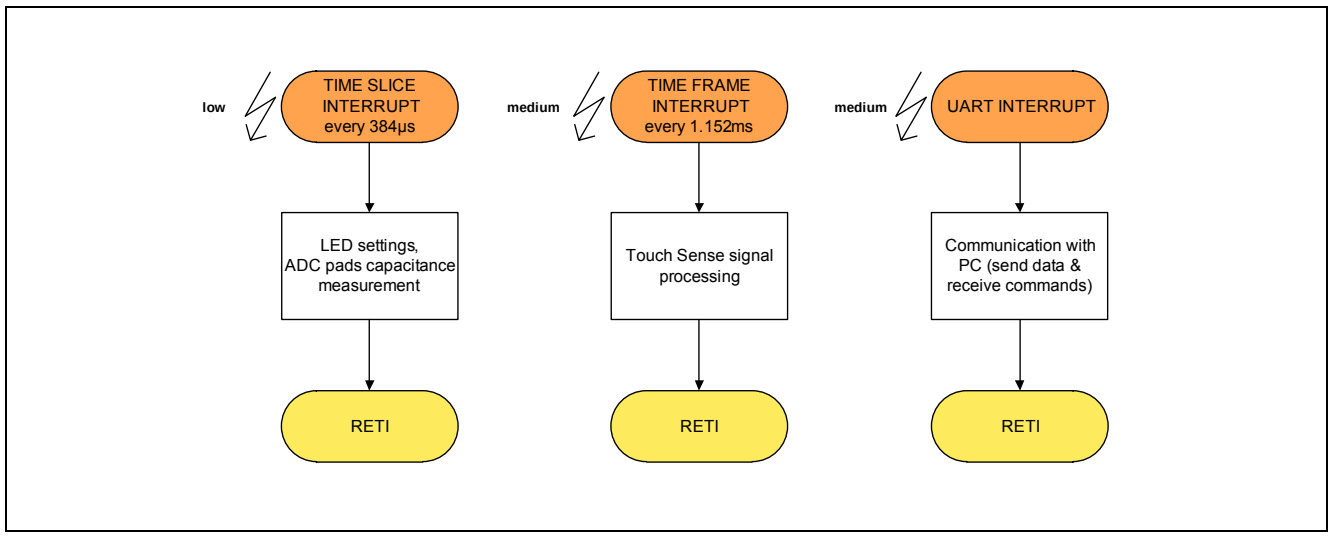

Figure 4 Program Overview - CR Method

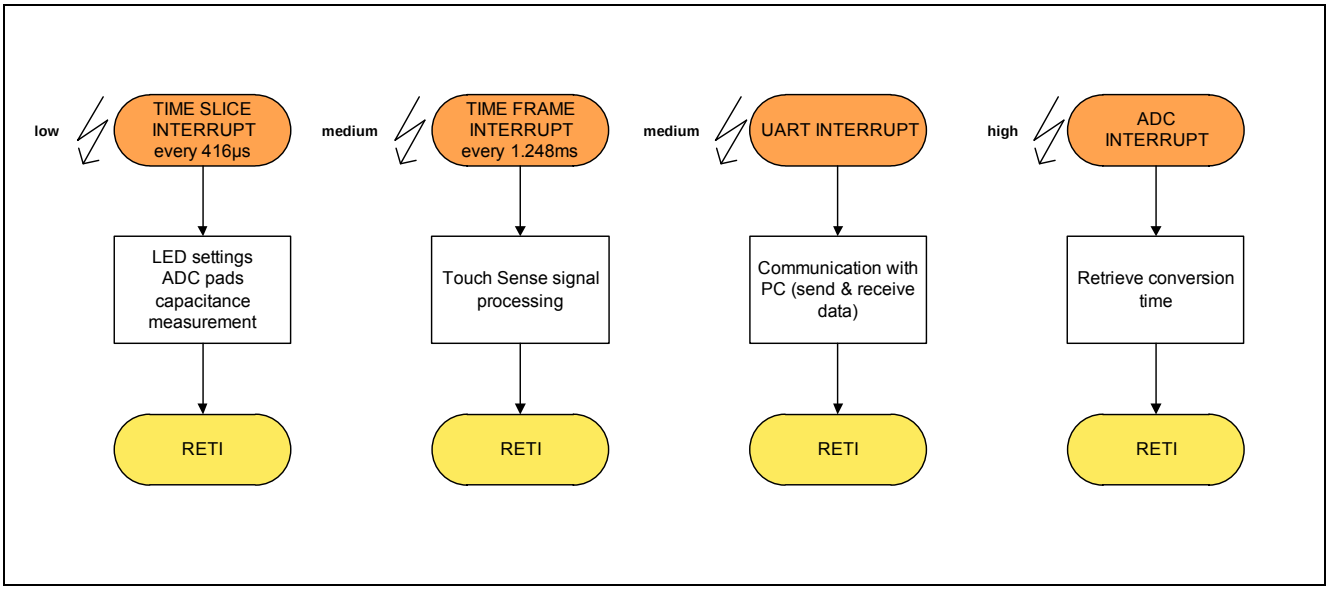

Figure 5 Program Overview - CTM Method

The tasks performed in each interrupt service routines are further illustrated in the flowcharts which follow:

- UART Interrupt (**Figure 6**)
  - The UART module, which is part of the XC800 core, is used for full-duplex UART communication with the PC.
- Time Slice Interrupt (**Figure 7**)
  - The LEDTS module generates this interrupt after every LED column activation where the pattern for the next LED column is loaded into shadow registers.
- Time Frame Interrupt (**Figure 8**)
  - The LEDTS module generates this interrupt after every measurement where signal processing and touch detection take place.
- ADC Interrupt (**Figure 9**)
  - The ADC generates this interrupt after the pad has been charged to the defined level, so that the charge-time can be measured.

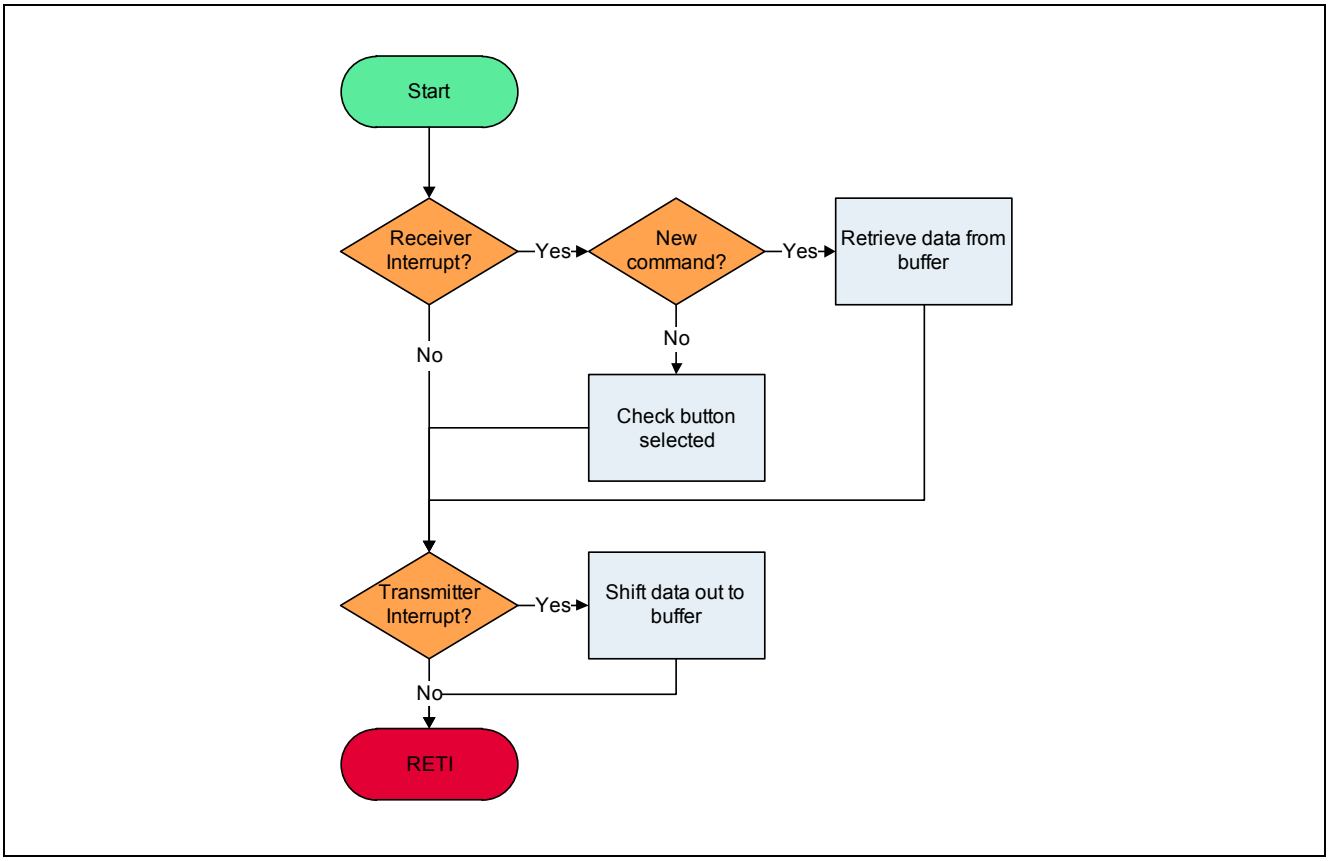

Figure 6 UART Interrupt Service Routine

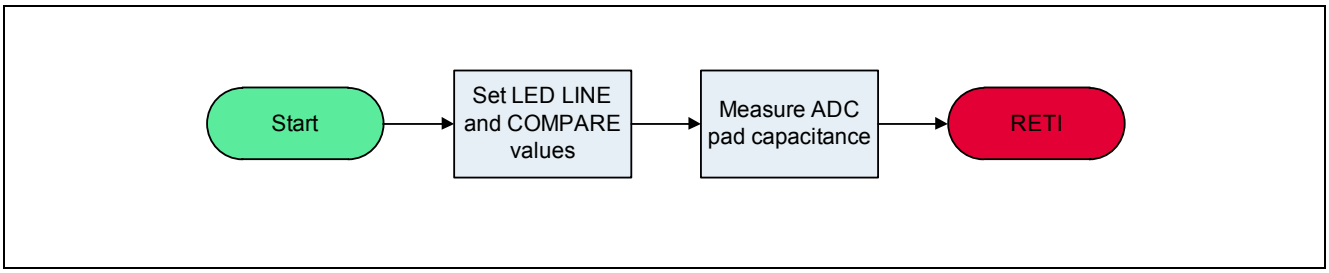

Figure 7 Time Slice Interrupt Service Routine

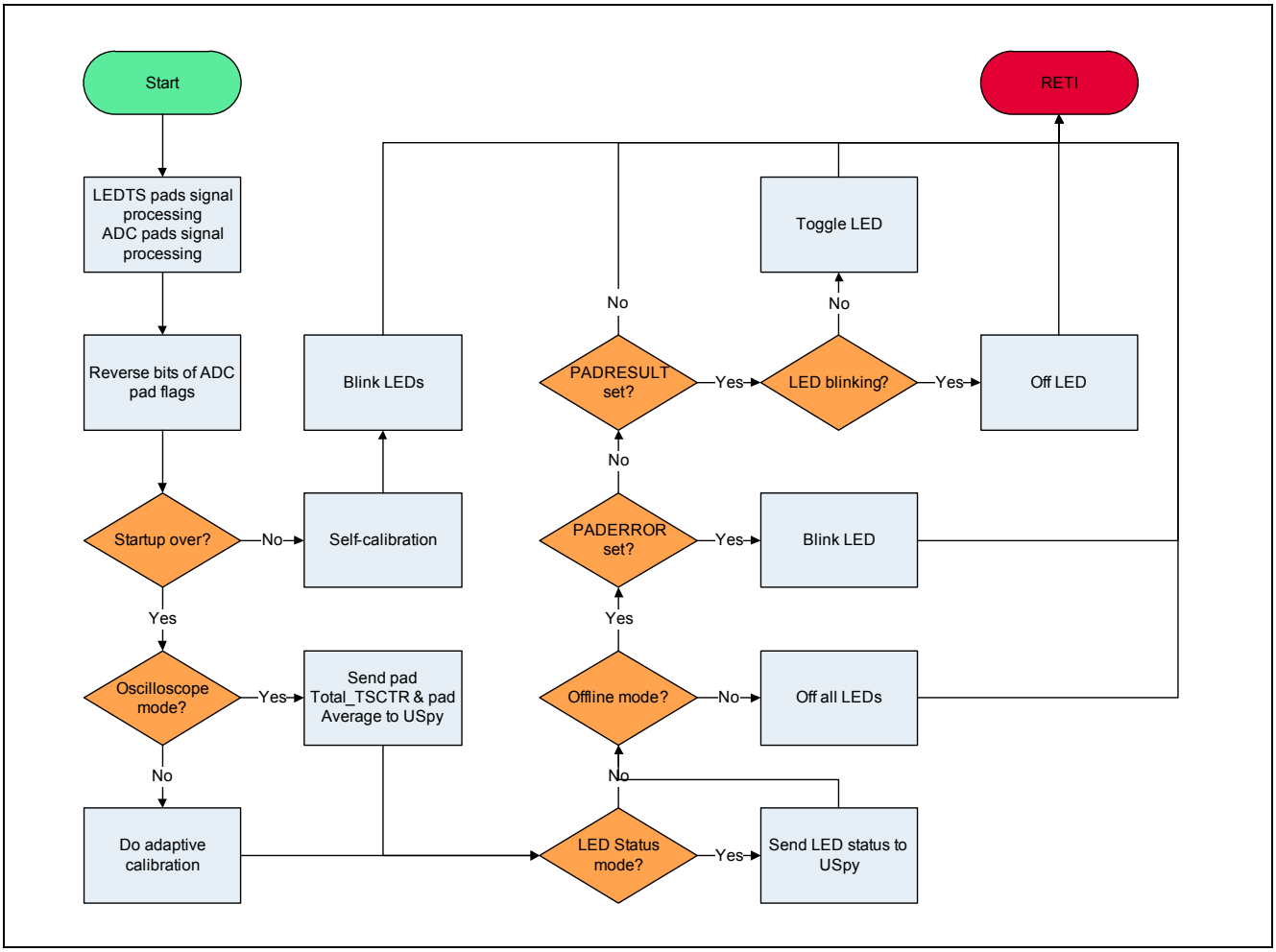

Figure 8 Time Frame Interrupt Service Routine

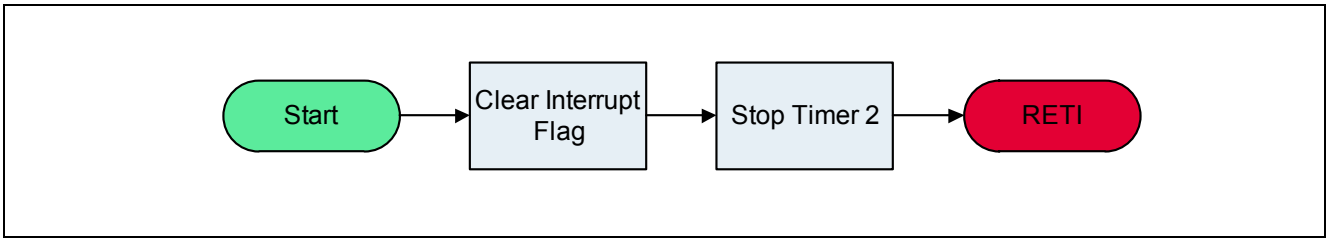

Figure 9 ADC Interrupt Service Routine (CTM Method)

3 Behavior

The inTouch Buttons board has 4 software versions:

1. The LEDs light up when respective pads are touched, using the CR method for the ADC touch pads (this is the default software).
2. LEDs toggle when respective pads are tapped, using the CR method for the ADC touch pads.
3. The LEDs light up when respective pads are touched, using the CTM method for the ADC touch pads.
4. LEDs toggle when respective pads are tapped, using the CTM method for the ADC touch pads.

Software versions 1 and 3 use the PADFLAG output of the LEDTS ROM Library and the PADTOUCHED output of the ADC Touch Library to implement the touch behavior as described above. Software versions 2 and 4 use the PADRESULT outputs of the LEDTS ROM Library and the ADC Touch Library to implement the touch behavior described above.

All software versions use the PADERROR output of the LEDTS ROM Library and the ADC Touch Library to blink the LEDs when there is a long touch on the buttons.

4 U-SPY

For the inTouch Buttons board, one settings file, **inTouch_Buttons.ini**, has been configured.

4.1 inTouch_Buttons.ini

This settings file (**Figure 10**) is customized to allow the user to monitor the parameters of the LEDTS ROM Library and the ADC Touch Library.

Figure 10 inTouch_Buttons.ini User Interface

Buttons

In this settings file, the buttons allow the user to choose the signal which the user would like to monitor. The description of the data format for the buttons is the same as in the previous settings file. Data is transmitted in the following format (**Table 1**):

Table 1 Transmit Data Format for Buttons

	D0	D1
Value (hex)	08	XX
Description	I.D. number	Button number

The data received by the microcontroller will be used to determine the signals that will be transmitted to U-SPY for display either as **Status Flags** (if LED Status button is selected) or on the **Oscilloscope** (if TSPADx or ADCPADx is selected). If OFFLINE is selected, the microcontroller will stop sending data to U-SPY, and all touches will be indicated by the LEDs on the board.

Status Flags

The format of the transmitted data for the status flags is as follows (**Table 2**):

Table 2 Transmit Data Format for Status Flags

	D0	D1	D2
Value (hex)	A3	30/31	XX
Description	I.D. number	TSLED - 30 ADCLED - 31	Mask

The statuses of the LEDs received by USpy are masked before they are displayed as status flags. It is important that the bits of a mask do not overlap with the bits of another mask. This is to ensure that status flags are not falsely turned on. The masks used are as follows (**Table 3**):

Table 3 LED masks for Status Flags

LED Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Mask (hex)	01	02	04	08	10	20	40

Oscilloscope

The oscilloscope function allows the user to monitor up to 3 signals per oscilloscope at a time (**Figure 11**). A total of 3 oscilloscopes are available. However, we will display only 2 signals on 1 oscilloscope in this application. The format of the transmitted data for the oscilloscope is as follows (**Table 4**):

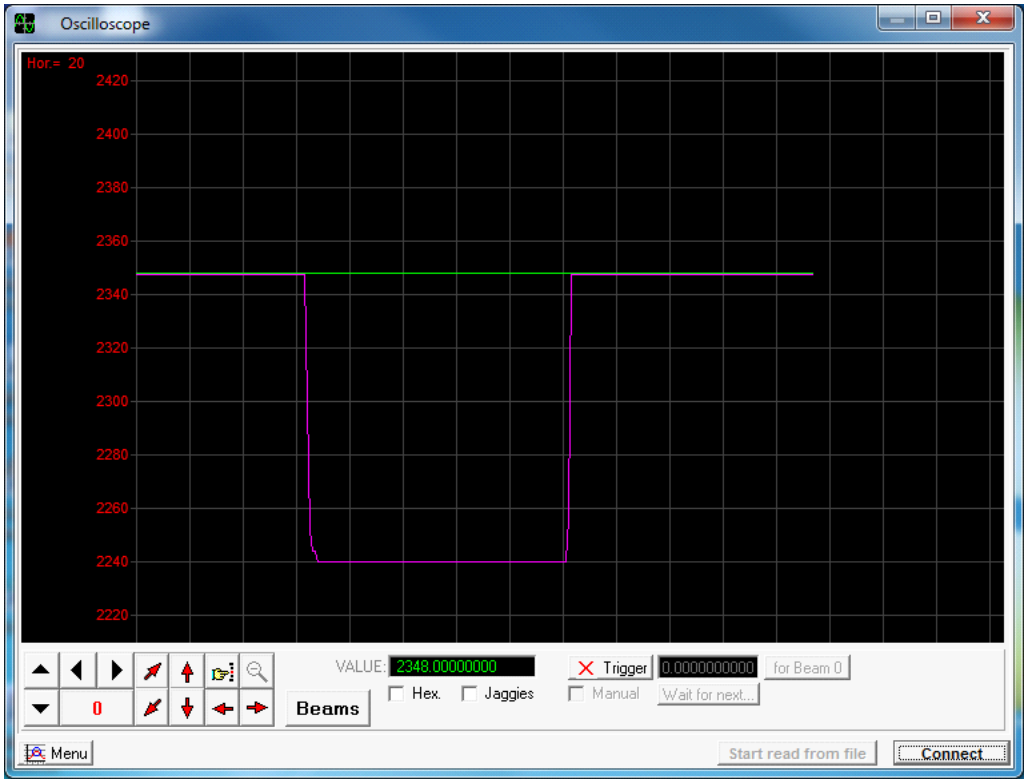

Figure 11 U-SPY Oscilloscope

Table 4 Transmit Data Format for Oscilloscope

	D0	D1	D2	D3	D4	D5	D6	D7
Value (hex)	A4	01	XX	XX	XX	XX	XX	XX
Description	I.D. number	Scope number	Signal 1 high byte	Signal 1 low byte	Signal 2 high byte	Signal 2 low byte	-	-

The signals displayed are as follows (**Table 5**):

Table 5 Signals Displayed on Oscilloscope

	Signal 1	Signal 2
Description	Pad Average	Pad Total_TSCTR * $2^{DIVISORN}$
Colour	Green	Pink

Appendix - Schematics and Layout

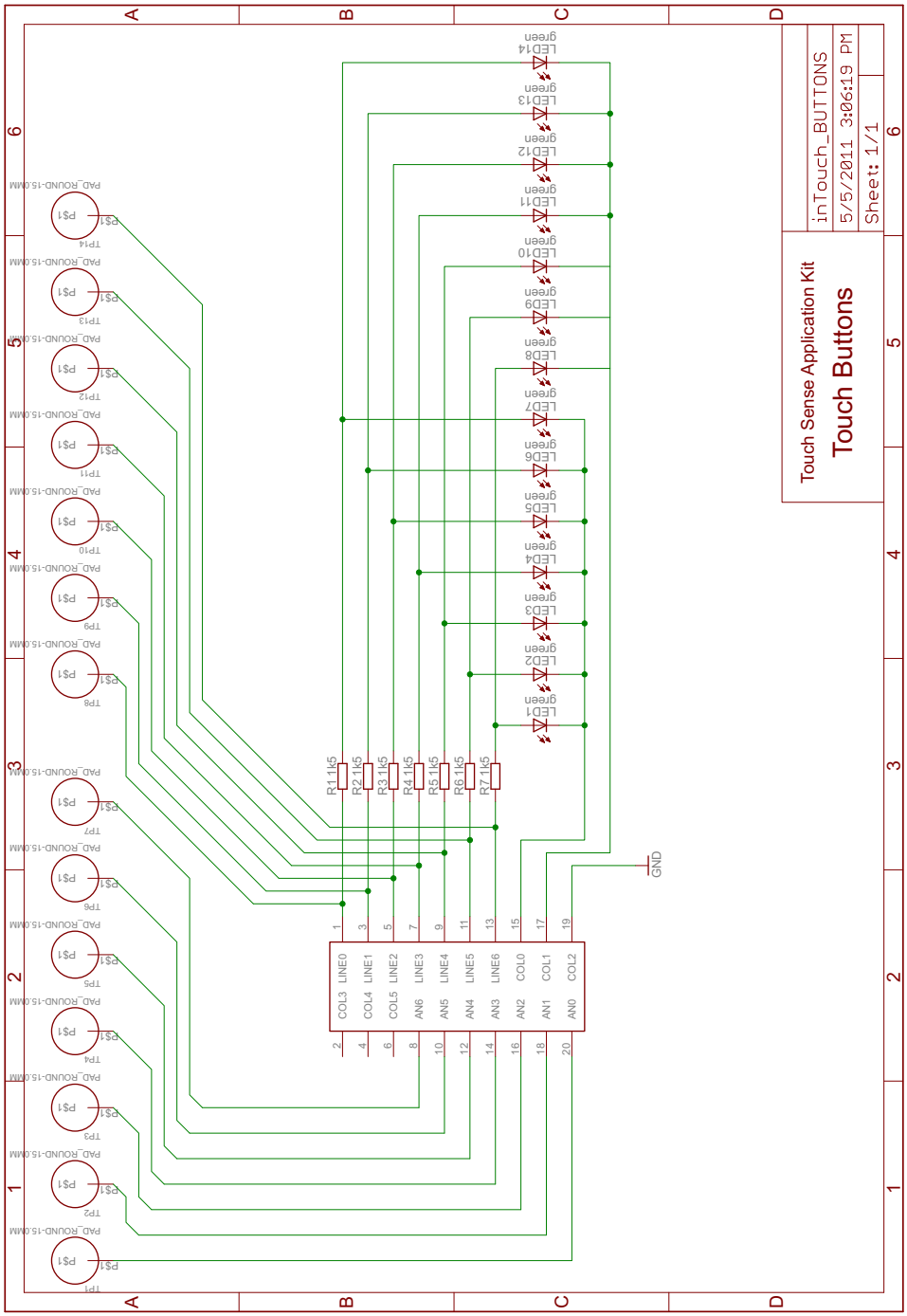

Figure 12 *inTouch Buttons* Board Schematics

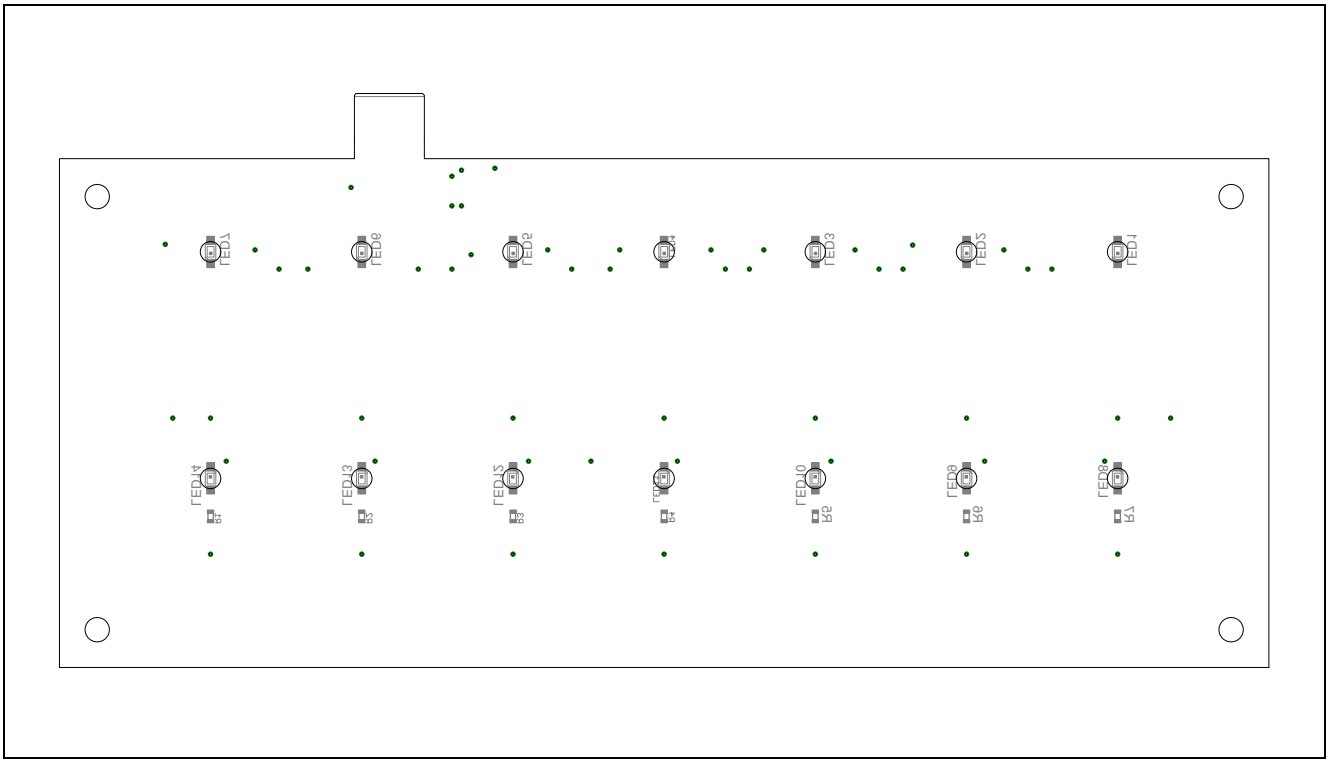

Figure 13 *inTouch Buttons* Board Component Bottom Layout

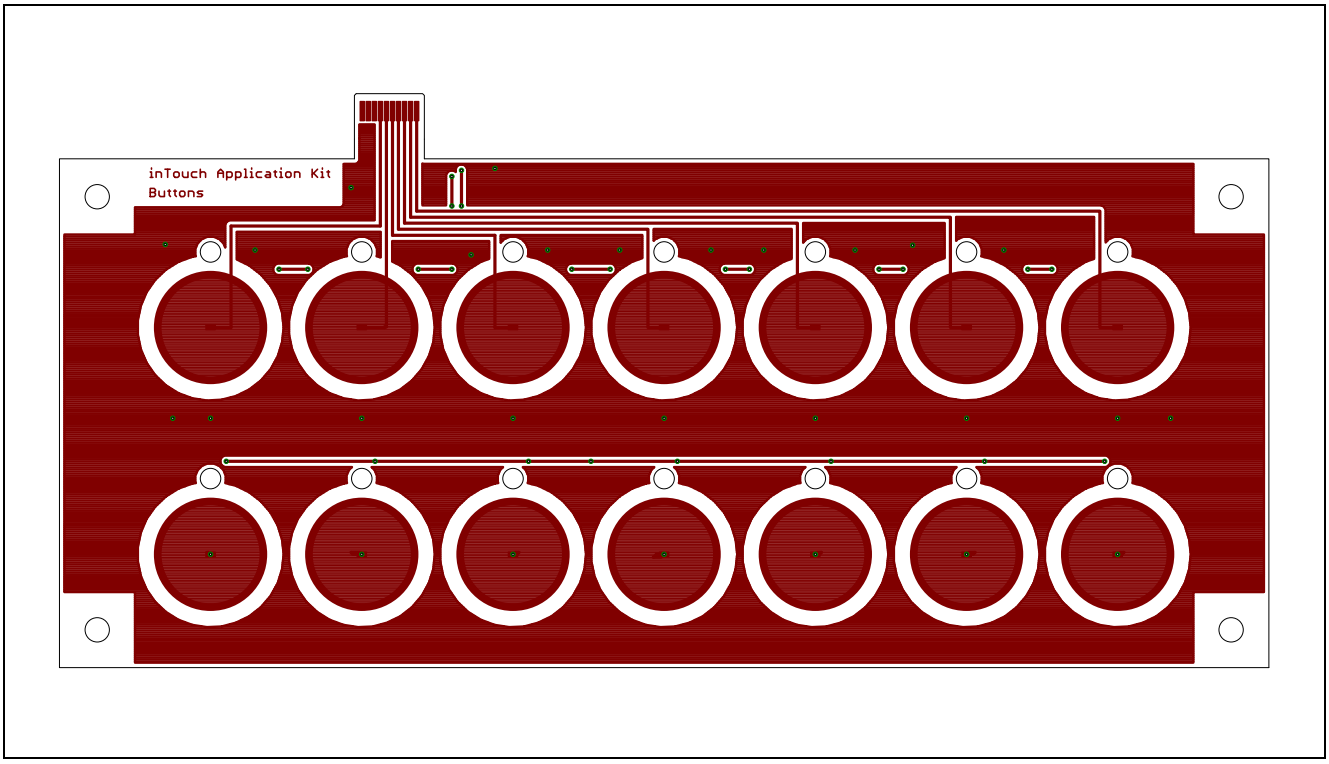

Figure 14 *inTouch Buttons* Board Top Layout

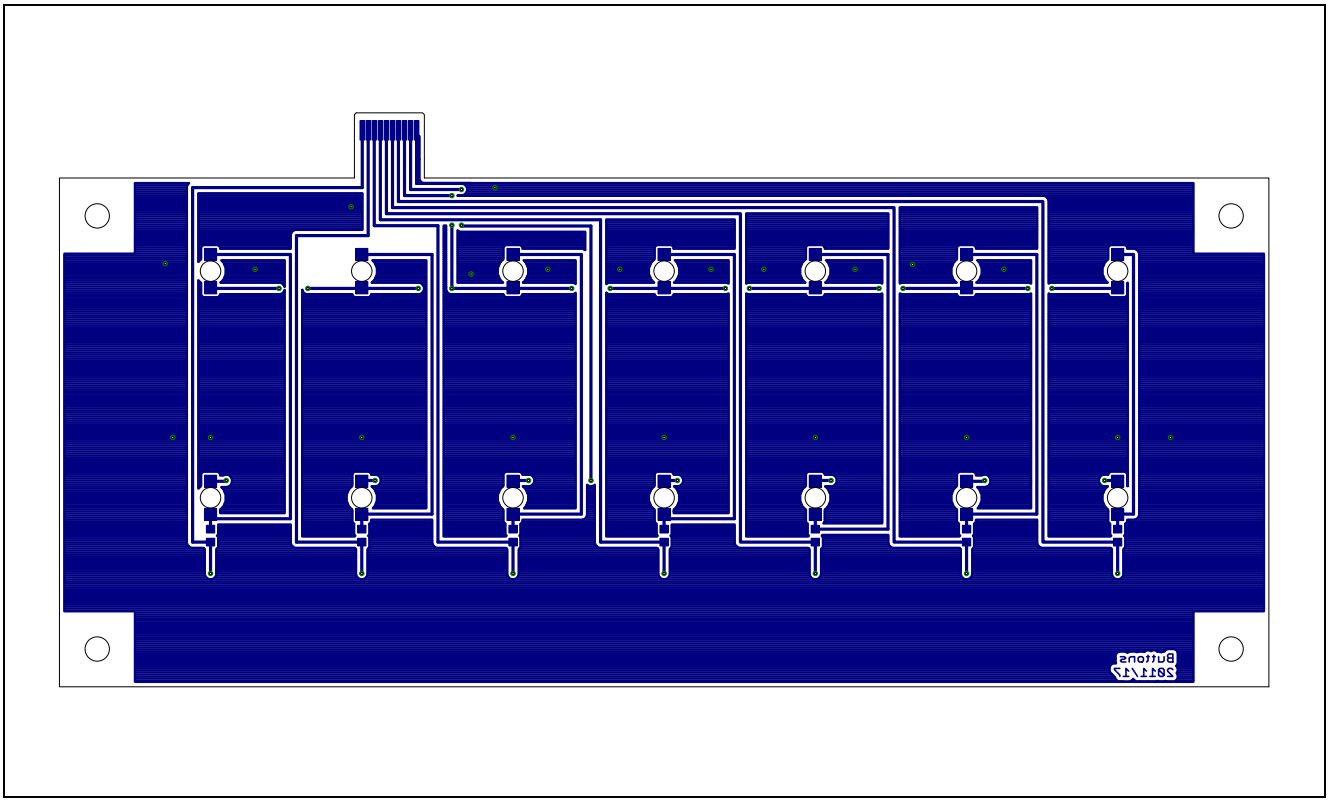

Figure 15 *inTouch Buttons* Board Bottom Layout

References

The list below provides resources that may be useful to the user.

1. User's Manual - *XC83x; 8-Bit Single-Chip Microcontroller*
2. Application Note - *AP08100 - Configuration for Capacitive Touch-Sense Application*
3. Application Note - *AP08110 - Design Guidelines for XC82x and XC83x Board Layout*
4. Application Note - *AP08113 - Capacitive-Touch Color Wheel Implementation*
5. Application Note - *AP08115 - Design Guidelines for Capacitive Touch-Sensing Application*
6. Application Note - *AP08121 - Infrared Remote Controller with Capacitive Touch Interface*
7. Application Note - *AP08122 - 16-Button Capacitive Touch Interface with XC836T*
8. Application Note - *AP08124 - XC82/83x Design Guidelines for Electrical Fast Transient (EFT) Protection in Touch-Sense Applications*
9. Application Note - *AP08126 - Infineon Touch Solutions - inTouch Application Kit*
10. Application Note - *AP08128 - inTouch Application Kit - Touch Wheel*
11. Application Note - *AP08129 - inTouch Application Kit - Touch Sliders*
12. Application Note - *AP08130 - inTouch Application Kit - LED Matrix*
13. Link to *XC83x-Series* - **www.infineon.com/xc83x**
14. Link to *Solutions for advanced touch control* - **www.infineon.com/intouch**

w w w . i n f i n e o n . c o m

Published by Infineon Technologies AG